ALICAT SCIENTIFIC

A **Halma** company

OPERATING MANUAL

FOR LIQUID FLOW CONTROLLERS

Models LC · LCR · LCS · LCRS

Thank you for purchasing your liquid flow controller.

If you have any questions, or if something is not working as expected, please contact us. We are eager to help you in any way possible.

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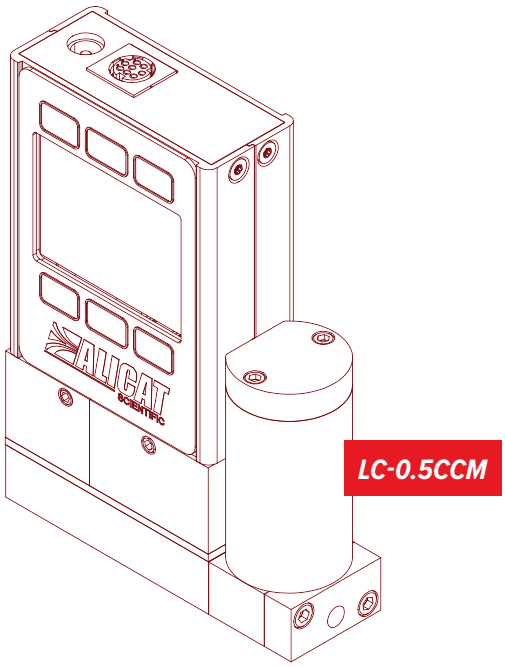
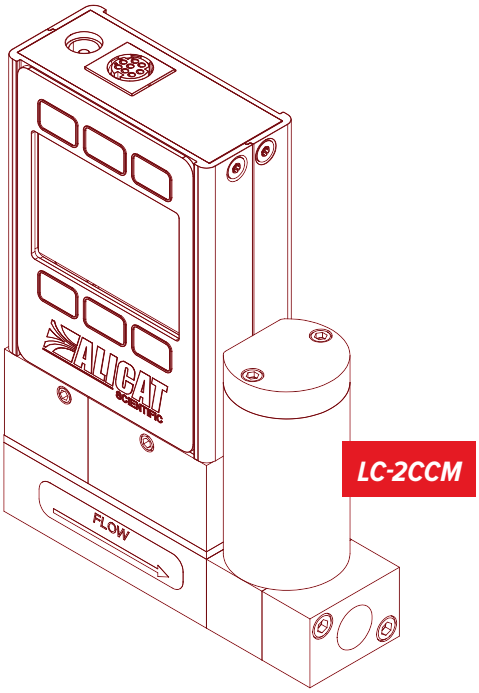




Recalibrate your liquid flow controller every year.
Annual calibration is necessary to ensure the accuracy of readings, and extend the Limited Lifetime Warranty. Fill out the Service Request Form at alicat.com/service, or contact us directly when it is time for recalibration.

For devices ordered with CSA, ATEX, ISO 17025, or other certifications, please visit alicat.com/certifications. For information about our limited lifetime warranty, visit alicat.com/warranty.

Serial #:_____

Next Calibration: _____

NIST This device comes with a NIST-traceable calibration certificate.

RoHS This device conforms to the European Union's Restriction of Use of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive 2011/65/EU.

CE This device complies with the requirements of the Low Voltage Directive 2014/35/EU and the EMC Directive 2014/30/EU and carries the CE Marking accordingly.

This device complies with the requirements of the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC

DOC-MANUAL-LC Rev 1, 2021.05.26

Introduction

Your new flow controller has a variety of innovative features:

- **Control pressure while monitoring volumetric flow rate.** Set the closed loop control algorithm to pressure control, page 28.
- **1000 readings per second** guarantees high resolution data, page 15.
- **Monitor live pressure and temperature** during flow control, page 6.
- **Backlit display with adjustable contrast** is easy to read even in direct sunlight. In dimly lit areas, press the logo to turn on the backlight, page 18.
- **Connection to a computer** for control and data logging to capture all flow and pressure data for logging and analysis, page 19.

This manual covers the following instruments:

- **LC-Series:** liquid flow controllers
- **LCS-Series:** anti-corrosive liquid flow controllers

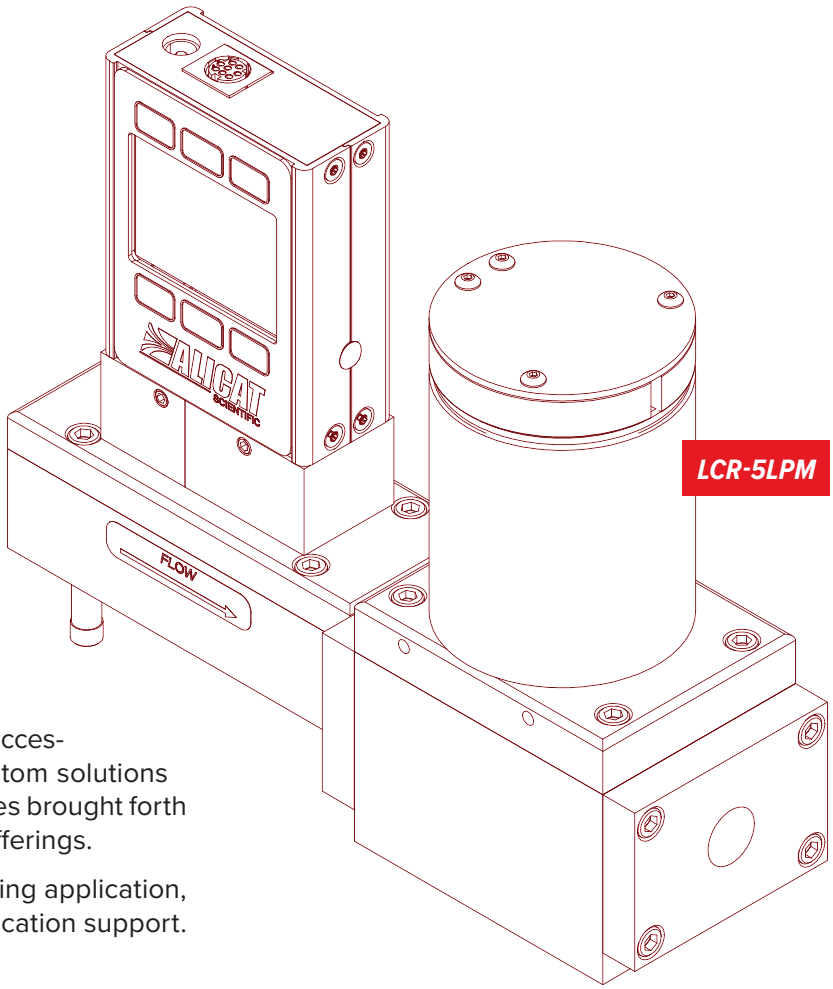
Using Laminar Liquid Flow Devices

THE DEVICE IS ONLY CONFIGURED FOR ONE TYPE OF LIQUID, AND WILL ONLY FUNCTION PROPERLY WHEN USING THAT ONE LIQUID.

By default, liquid devices are configured only for use with pure water, such as distilled, de-ionized, Type I (Ultrapure), Type II, and Type III. If a device is used for any liquid other than the liquid it was specifically engineered for, readings will be incorrect

Minimize contaminants and liquid variations. For water devices, **DO NOT** use tap water or water with any biological components, minerals, or oils. Any of these substances will affect the viscosity of the liquid, leading to inaccurate flow measurements. More importantly, **these impurities will quickly build up in the laminar flow zone, cause corrosion, and degrade the measurement accuracy of the device.**

For support or questions regarding the use or operation of this device, please contact us using the information on page 2.



Alicat offers countless combinations of device sizes, accessories, connections, and configurations. These custom solutions are offered to meet a variety of application challenges brought forth by users pushing the boundaries of our standard offerings.

If you have an idea for a new process or a challenging application, contact Alicat for specialized engineering and application support.

Contents

Quick Start Guide

Setup

- **Connect your liquid controller.** Ensure that flow will pass through your device in the same direction as the arrow on the flow body (usually left to right).
- **Choose your engineering units.** You can choose the measurement units by selecting **`MAIN MENU` → `SETUP` → `Sensor` → `Engineering Units`** (page 17).

Operation: Flow Verification

- **Monitor live volumetric flow, temperature, and pressure readings.** Readings are updated and displayed on your device in real time (page 15).
- (Optional) **Capture totalized readings.** The totalizer option displays the total flow that has passed through the device since the last time the totalizer was reset. If your device has a totalizer, press **`NEXT`** from the main live data display to access the totalizer (page 10).

Connectors and Buttons

The drawing to the right represents a typical configuration of a standard liquid flow controller. **Your liquid flow controller's appearance and connections may differ.** page 3 has more examples.

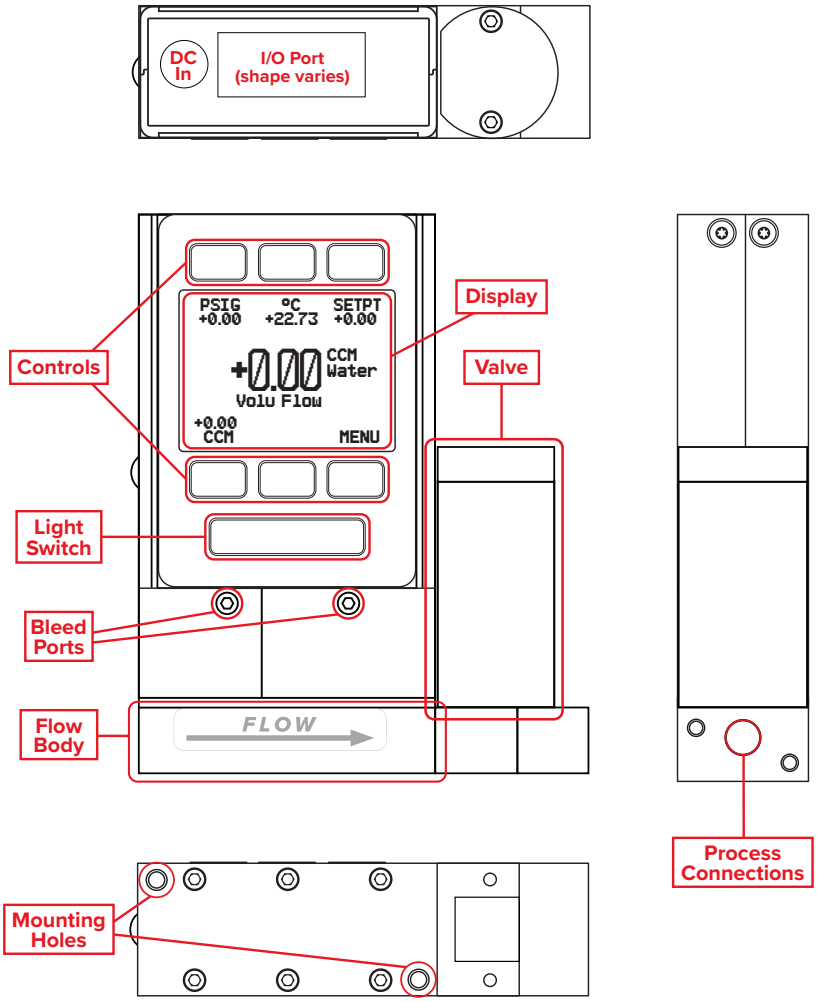
Backlight

The monochrome display comes equipped with a backlight. **To toggle the backlight power, press the logo on the front of your device.**

For optional color TFT displays, pressing this button will turn off the display to conserve power (page 9).

Maintenance and Care

- Liquid flow controllers require minimal cleaning and maintenance when flowing clean liquids (page 23).
- Calibrate your liquid flow controller annually. To schedule a calibration, please contact support (page 2).



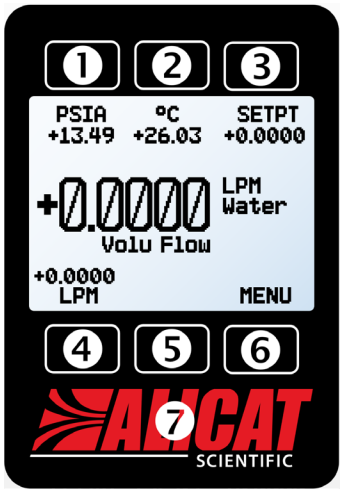
This LC-10CCM model liquid flow controller is a typical device. The flow body and the valve sizes can vary significantly.

Getting Started

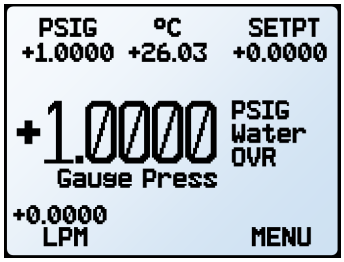
Getting to Know Your Liquid Flow Controller

The Liquid Flow Controller Display

The figure to the right identifies the various features of the flow meter display.



*The **main display**. Note the button behind the logo, which toggles the device backlight.*



*The **main display** with a PSID (PSI-differential) pressure reading.*

1. Highlights **pressure** in the center of the device.
2. Highlights **temperature** in the center of the device
3. Opens a menu to set the **flow or pressure control setpoint** (page 12).
4. Highlights **volumetric flow** rate in the center of the device.
6. **MENU** enters the **main menu** system.
   NEXT accesses the optional **flow totalizer** (page 10).
7. Toggles the backlight.

Status Messages

Status messages are shown to the right of the main readout number. In the example to the right the **OVR** message shows that the totalizer rolled over to zero.

ADC Analog-digital converter error
EXH Exhaust mode active
HLD Valve hold active
LCK Front display is locked
OVR Totalizer rolled over to zero
POV Pressure over range of device
TMF Totalizer missed out-of-range flow
TOV Temperature over range of device
VOV Volumetric flow over range of device

Mounting

Liquid flow controllers do not require straight runs of pipe upstream or downstream. Most flow controller models can be mounted in any position, including upside-down. All liquid flow controllers use media-isolated sensors that must be tared after changing orientation.

Note: *If air bubbles are continuously introduced to the flow upstream of the device, the device may be mounted upside down to prevent bubbles from being trapped in the pressure sensor ports. Tare the device after changing its position or orientation.*

Warning: *If the device has been installed upside down, avoid using the bleed screws as liquid may leak into the electronics housing and cause permanent damage that is not covered by the warranty.*

Caution: *Flow controllers that use large Rolamite valves should be mounted with their valve oriented vertically (right-side up). If another orientation is desired, please contact support.*

Filters

When pressure drop is not a concern, use in-line sintered filters to prevent large particulates from entering the flow body of the controller. Suggested maximum particulate sizes are as follows:

- **20 microns** for units with flow ranges ≤100 CCM.
- **40 microns** for units with flow ranges >100 CCM.

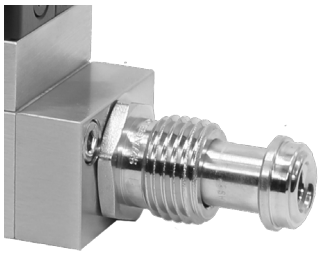
Note: *Avoiding long runs of small-diameter tubing upstream or downstream of the device will reduce liquid hammer.*

Device Ports

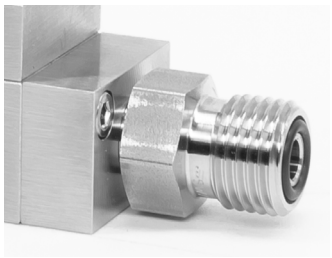
Your flow controller has been shipped with plastic plugs fitted into its ports. To lessen the chance of contaminating the flow stream, do not remove these plugs until you are ready to install the device.

Standard liquid flow controllers have female inlet and outlet ports. Welded VCR® and other specialty fittings may have male connections.

- If you are using a fitting that does not have a face seal, use thread-sealing Teflon tape to prevent leakage around the port threads, but do not wrap the first two threads entering the device. This will minimize the possibility of getting tape into the flow stream and clogging the laminar flow elements.
- Face seal fittings do not need Teflon tape applied to the threads.



A VCR®-compatible connection.



A VCO®-compatible connections.

Warning: *It is not recommended to use pipe dopes or sealants on the process connections as these compounds can cause permanent damage to the controller should they get into the flow stream.*

Your flow controller can measure and control flow generated by positive pressure and/or suction. Connect the controller so that the flow travels in the same direction as the flow arrow, usually from left to right from the front of the device.

Operating Pressure

Maximum operating line pressure is **100 PSIG**. If the line pressure is higher than 100 PSIG, use a pressure regulator upstream to reduce the pressure. Maximum proof pressure is 200 PSIG; above this pressure the device may be permanently damaged.

Caution: *Exceeding the maximum specified line pressure may cause permanent damage to the solid-state differential pressure transducer.*

Bleed Ports

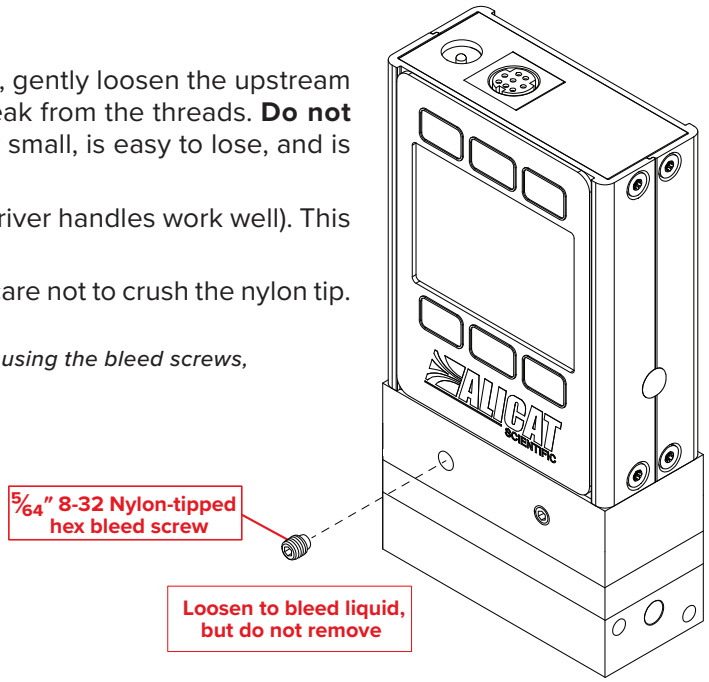
Liquid flow controllers include bleed ports (8-32 Nylon tapped screw) on the front for the removal of air bubbles.

Note: *A small amount of liquid will leak from the device during this procedure. Take necessary precautions to prevent damage to anything nearby.*

Bleed both of the ports as follows:

1. With the controller installed, and a >50% setpoint given, gently loosen the upstream bleed port screw 1 to 2 turns, or until liquid begins to leak from the threads. **Do not remove the screw**, as it has pressure behind it, is very small, is easy to lose, and is delicate to rethread.
2. Gently tap the flow body to remove air bubbles (screwdriver handles work well). This may not be visible or audible.
3. Gently tighten the screw until the leakage stops, taking care not to crush the nylon tip.

Note: *If your device is mounted in an inverted position, avoid using the bleed screws, as liquid may leak and cause permanent damage.*

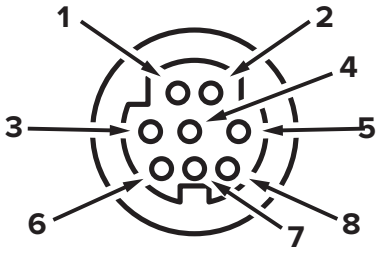


Power and Signal Connections

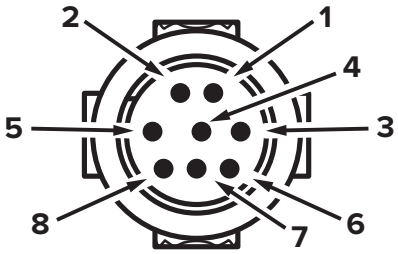
Power can be supplied to your controller through either the power jack or the multi-pin connector on top of your device.

Note: *Power requirements vary based on analog configuration and valve type. Please reference the associated specification sheet at alicat.com/specs for power requirements.*

Standard 8-Pin Mini-DIN Pinout



Female Connector: Device



Male Connector: Cable

Pin	Function
1	Not connected *Optional: 4–20 mA primary output signal*
2	Static 5.12 Vdc by default. *Optional: secondary analog output (4–20 mA, 0–5 Vdc, 1–5 Vdc, 0–10 Vdc) or basic alarm*
3	Serial RS-232 RX / RS-485(–) input signal (receive)
4	Analog setpoint input
5	Serial RS-232 TX / RS-485(+) output signal (send)
6	0–5 Vdc *Optional: 1–5 Vdc or 0–10 Vdc output signal*
7	Power in (as described above)
8	Ground (common for power, digital communications, analog signals and alarms)

The above pinout is applicable to all devices with the Mini-DIN connector. The availability of different output signals depends on the options ordered. Optional configurations are noted on the unit's calibration sheet.

Caution: *Do not connect power to pins 1 through 6, as permanent damage can occur. It is common to mistake pin 2 (labeled 5.12 Vdc Output) as the standard 0–5 Vdc analog output signal. Pin 2 is normally a constant 5.12 Vdc.*

For more pinout configurations, see diagrams starting on page 25.

Analog Signals

Primary Analog Output Signal

Most instruments include a primary analog output signal, which is linear over its entire range. For all analog output configurations, the lowest output indicates zero flow, and highest indicates full-scale flow. Depending on the quality of the grounding, a zero flow condition is approximately 0.010 Vdc.

For example, a 5 Vdc output from a 0–5 Vdc 100 CCM unit would indicate a flow of 100 CCM.

Option: Secondary Analog Output Signal

The default 8-pin Mini-DIN connector places the secondary analog output on pin 2 for both voltage and current signals. Your device's secondary analog signal may differ from its primary output signal.

The calibration sheet that shipped with the device shows which output signals were ordered.

Option: 4–20 mA Current Output Signal

If your controller has a 4–20 mA current primary or secondary output signal, your flow controller will require 15–30 Vdc power.

Caution: *Do not connect 4–20 mA devices to "loop powered" systems, as this will damage portions of the circuitry beyond repair and void the warranty. If you must interface with existing loop powered systems, always use a signal isolator and a separate power supply.*

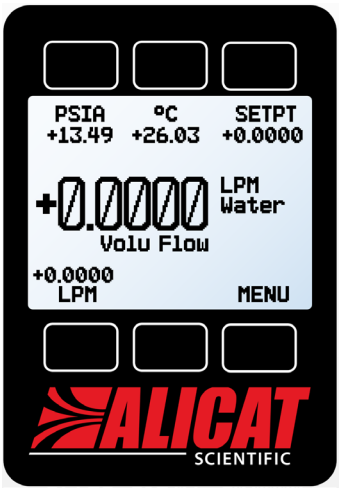
Displaying Live Flow Data

Main Display

The main display has three primary functions:

- Displaying live temperature, pressure, and flow data
- Changing the flow or pressure control setpoint (page 12)
- Accessing the **main menu** (**MENU**) or the optional totalizer (**NEXT**) (page 10)

This screen displays live data for all flow parameters simultaneously. Live data is measured 1000 times per second and the LCD display is updated 10 times per second. The button next to the four measurements highlight their values in the center.



*The **main display**. Note the button behind the logo, which toggles the device backlight.*

Taring Your Flow Controller

MENU → TARE FLOW *or* **TARES**

Taring is an important practice that ensures your flow controller provides its most accurate measurements. This function gives the flow controller a zero reference for flow measurements. Gauge pressure can also be tared on all liquid devices.

How to Tare

When autotare is on (**Autotare: On**), flow rate is tared when a zero setpoint is given for more than two seconds (page 12).

Taring Flow

MENU → TARES → TARE FLOW

Flow tares should take place at the expected process pressure, with no flow. A message, "**ENSURE NO FLOW BEFORE PRESSING TARE**" will be displayed. Press **TARE** to complete the taring process.

Taring Pressure

MENU → TARES → TARE PRESS

After pressing **TARE PRESS**, the message, "**PRESS TARE WHEN VENTED TO AMBIENT WITH NO FLOW**", followed by "**CURRENT PRESSURE OFFSET**:" will be displayed.

When to Tare

- Before every new flow measurement cycle
- After significant changes in temperature or pressure
- After dropping or bumping the flow controller
- After changing the device's orientation

Option: Color TFT Display

Instruments ordered with a color display are functionally the same as standard backlit monochrome instruments. The color enables additional on-screen information.

Multi-Color Display Indicators

- **GREEN**: Parameter labels and adjustments associated with the button directly above or below the label are green.
- **WHITE**: The color of each parameter will be displayed in white when the device is operating within device specifications.
- **RED**: The color of a parameter will be displayed in red when its value exceeds 128% of the device's specifications.
- **YELLOW**: Menu items that are ready to be selected appear in yellow. This color replaces the > symbol in selections on monochrome display.

Note: *Press the logo to turn off the color display backlight. The flow controller remains in operation while the backlight is off.*

Note: *Color displays will require an additional 40 mA when using a 12 Vdc power supply. All other device specifications from your device's specification sheet remain in effect.*

Option: Collecting Totalized Flow Data

MAIN DISPLAY → NEXT (totalizer menu)

The optional flow totalizer displays the total amount of mass or volume that has flowed through the instrument since its last reset, similar to a gasoline pump. It also enables batch dispensing (page 10).

- **TOTAL/TIMER** toggles between totalized flow and elapsed time as the highlighted parameter in the center.
- **SETPT** displays the current setpoint. Press to set a new setpoint, or to clear the setpoint (page 12).
- **LPM** (or another measurement of volumetric flow) displays the live flow rate. Press to change engineering units.
- **(Optional) V AVG**: Shows totalizer averaging, which displays average flow rate since last reset, updated live.
- **BATCH** selects the quantity to be dispensed in each batch. **–NONE–** appears if the batch mode is off.
- **RESET** clears all totalized data and immediately resets the timer to zero. The next batch, if set, begins immediately.
- **MENU** enters the **main menu**.

Totalizer Rollover Functions

The totalizer will report a maximum of 7 digits. By default, the placement of the decimal is the same as the live flow rate. The totalizer can be configured at the time of order for the following behaviors:

- **Rollover (Default):** Totalizer resumes counting from zero as soon as the maximum count has been reached.
- **Freeze:** Totalizer stops counting at max count, until it is reset manually.
- **Error (Default):** Displays **OVR** status message when maximum count has been reached; compatible with the rollover and freeze functions.

The elapsed time counter has a maximum value of 9999:59:59 (h:m:s) (416 days, 16 hours). If flow is still being totalized at that point, the timer freezes, regardless of the behavior chosen above for the totalized flow readings.

Dispensing in Batches

Batch dispensing allows you to choose a desired total volume to flow, after which the valve closes. You can repeat batches with a single button press. A totalizer is required to dispense batches.

Starting batch dispensing

1. From the totalizer screen, press **BATCH**. Choose the total quantity to be dispensed in each batch. Press **SET** to accept the new batch size.
2. From the totalizer screen (page 10), press **SETPT** to choose a non-zero setpoint. Flow begins as soon as you press **SET**.

Note: *Batch dispensing requires an active batch size and a non-zero setpoint. If your controller already has a non-zero setpoint, flow begins as soon as you press SET from the batch size screen.*

While a new batch is being dispensed, the **BATCH** button changes to show the quantity that remains to be dispensed. When the batch size has been achieved, the **BATCH** button displays **–DONE–** and flow stops automatically.

The batch size can be changed while a batch is in progress. If the new batch size is larger than the current totalized flow, then flow continues until the new value is reached. If the new batch size is smaller than the current totalized flow, then the flow stops immediately. Press **RESET** to start the new batch.

Repeating a Batch

- For an identical, new batch, press **RESET**. Flow begins immediately.
- For a new batch of a different size, press **BATCH**, and select the new batch size. If there is a non-zero setpoint, flow will begin as soon as **SET** is pressed.

Pausing or Canceling a Batch

1. To stop flow while a batch is in progress, set the flow setpoint to zero by pressing **SETPT → CLEAR → SET** within the **totalizer menu**. This will not stop the timer. Resume flow with a non-zero set point.
2. To remove a batch setting, press **BATCH** *or* **REMAIN → CLEAR → SET**. Deleting the batch does not affect the setpoint. Flow will continue at the setpoint rate.

Warning: *Flow will resume immediately at the current setpoint when batch dispensing is turned off.*

Note: *The batch size is retained across power cycles of your flow controller. It must be manually cleared when no longer desired.*

Using the Totalizer while Controlling Pressure

While using a liquid flow controller to control pressure, the flow rate may exceed the maximum measurable flow (128% of full scale) with an abrupt pressure change. In this case, the totalizer will use the maximum 12% of full scale as the measured flow rate, the totalized flow value will flash, and the **TMF** error will appear to indicate that the totalizer missed flow data. Reset the totalizer to clear the error message.

Setting an upper flow limit (page 15) within the readable range will prevent this error; however, this will take preference over reaching the pressure setpoint.

Warning: *In certain situations, it is possible to exceed the batch size. As an example, if the feed pressure is too low to achieve the flow setpoint and then pressure is suddenly increased, the batch size may be exceeded before the valve reacts to the sudden burst of pressure.*

Control

Changing the Setpoint

SETPT *or* **MENU** → **CONTROL** → **Setpt:**

The setpoint selection screen indicates the engineering units and maximum allowable setpoint (e.g., **LPM: +10.000 Max**). To cancel a setpoint, press **CLEAR**, then **SET**.

Adjusting Setpoint with an IPC

For controllers ordered with a potentiometer control knob (IPC), the setpoint source must be set to analog for the controller to receive setpoint commands from the IPC ("Changing Between Setpoint Sources" below).

Leave the IPC knob at the midpoint when it is not in use.

Setpoint Setup

Using Autotare

CONTROL → **Setpoint Setup** → **Zero Setpoint**

When the setpoint is zero, the controller will automatically tare itself if autotare is enabled (default). This menu also specifies how many seconds the controller will wait after given zero setpoint before taring, under **Delay Before Tare**.

Setpoint ramping (page 15) can either be set to honor the ramp rate limit or go to zero as quickly as possible.

Changing Between Setpoint Sources

CONTROL → **Setpoint Setup** → **Setpoint Source**

Liquid flow controllers with RS-232 or RS-485 communication will accept setpoints from the front panel and serial commands (page 19), or from an analog signal.

- When the source is set to **Serial/Front Panel**, the controller will accept input from either the front panel, or an RS-232/RS-485 connection. Neither source is a slave of the other, so the controller will accept the most recent command from either source.
- When the source is set to **Analog**, the device ignores serial setpoint commands and will prevent setpoint input from the front panel.

Setpoint with an Idle Modbus RTU Connection

CONTROL → **Setpoint Setup** → **On Modbus Timeout**

The device can be configured to set a zero setpoint after a certain amount of idle time on a Modbus connection. By default, it will maintain the setpoint indefinitely. See page 17 for configuration details.

Managing Setpoint on Power Up

Power-Up Setpoint Value

CONTROL → **Setpoint Setup** → **Power Up Setpoint** → **Value**

By default, the controller remembers its last setpoint across power cycles. However, it can be changed to give a specified setpoint upon power-up by selecting **Fixed Setpoint** and entering in the desired value. If the setpoint will be provided digitally more often than every few minutes, a fixed setpoint on power-up is preferred to avoid wearing out non-volatile memory in the device.

Power-Up Setpoint with Ramping

CONTROL → **Setpoint Setup** → **Power Up Setpoint** → **Ramp**

Any setpoint ramp will always start from zero on power-up. Similar to the zero setpoint option (page 15), the device can either honor the ramp rate (**Honor from 0**) or jump to setpoint (**Jump from 0**) as quickly as possible.

Establishing Setpoint Limits

CONTROL → **Setpoint Setup** → **Setpoint Limits**

The **setpoint limits menu** configures upper and lower limits for selecting a flow or pressure control setpoint. By default, the controller will only be limited by its measuring range; however, more strict limits may be beneficial in certain critical applications.

Over a serial connection, requesting a setpoint outside the limit will be rejected and an error will be returned. When using an analog setpoint signal, setpoints that are outside of the setpoint limits are treated as if they were at the nearest limit. For example, if you request a setpoint that is below the lower limit, the controller sets the setpoint at the lower limit.

Warning: *Flow controllers that have non-zero lower setpoint limits cannot be set to stop flow until the lower limit has been cleared.*

Note: *When changing from one control loop variable to another, the flow controller remembers setpoint limits as percentages of full scale. For example, a 1-LPM limit on an LCR-2LPM controller (50% of full scale) will become a limit of 50 PSIG (50% of 100 PSIG) if the control loop is changed to gauge pressure.*

Control Loop

Changing the Controlled Variable

CONTROL → Control Loop → Control

The controller can control the flow rate or the pressure in your process. Selectable control loop variables include volumetric flow, gauge pressure, and valve drive.

Note: *When pressure is selected as the control loop variable, flow controllers with upstream valves will control the outlet pressure. Those with downstream valves can control upstream backpressure, but these must be configured for this type of control.*

Warning: *When changing the control loop from volumetric flow to gauge pressure, you may need to adjust the PID settings for optimal stability and speed of response.*

Adjusting the PD/PDF or PD^{2}I Control Algorithms

CONTROL → Control Loop → Loop Type

Your liquid flow controller uses an electronic closed loop controller to determine how to actuate its valve(s) in order to achieve the commanded setpoint. These settings were tuned for your specific operating conditions, but changes to your process sometimes require on-site adjustments to maintain optimal control performance. If you encounter issues with control stability, oscillation or speed of response, fine-tuning your closed loop control may help.

For most applications, the PD/PDF algorithm is recommended.

Tuning the PD/PDF Control Algorithm

The controller's default control algorithm (PD) employs pseudo-derivative feedback (PDF) control, which uses two editable variables:

- The larger the **D** gain, the slower the controller will correct errors between the commanded setpoint and the measured process value. This is equivalent to the **P** variable in common PDF controllers.
- The larger the **P** gain, the faster the controller will correct for offsets based on the size of the errors and the amount of time they have occurred. This is equivalent to the **I** variable in common PDF controllers.

Note: *The D and P variables in the PD/PDF control algorithm are more typically referred to as P and I, respectively, in traditional PDF controllers.*

Tuning the PD^{2}I Control Alogrithm

The controller's PD^{2}I control algorithm (also called PDDI) is used to provide faster response, most commonly in dual-valve flow and pressure controllers. This algorithm uses typical PI terms and adds a squared derivative term (D):

- The larger the **P** gain, the more aggressively the controller will correct errors between the commanded setpoint and the measured process value.
- The larger the **I** gain, the faster the controller will correct for offsets based on the size of the errors and the amount of time they have occurred.
- The larger the **D** gain, the faster the controller will predict needed future corrections based on the current rate of change in the system. This often results in slowing the system down to minimize overshoot and oscillations.

Troubleshooting Valve Performance with PID Tuning

The following issues can often be resolved by adjusting the PID gain values for your liquid flow controller.

Fast oscillation around the setpoint

- **PD**: Reduce the **P** gain in decrements of 10%.
- **PD²I**: Increase the **P** gain in increments of 10%, and then adjust the **I** gain to fine-tune.

Overshot setpoint

- **PD**: Reduce the **P** gain in decrements of 10%.
- **PD²I**: If **D** is not 0, increase the **P** gain in increments of 10%.

Delayed or unattained setpoint

- **PD**: Increase the **P** gain in increments of 10%, and then decrease the **D** gain by small amounts to fine-tune.
- **PD²I**: Increase the **P** gain in increments of 10%, and then increase the **I** gain to fine-tune.

Note: *Valve tuning can be complex. More detailed information is available at alicat.com/pid.*

Limiting Flow while Controlling Pressure

`CONTROL → Control Loop → Flow Limiter`

Limiting the flow rate while controlling pressure can help to avoid exceeding the measurable range of the device as well as prevent damage of sensitive devices later in the process. To limit flow:

1. Set the maximum value of flow rate desired by pressing **`MAX FLOW`** and entering the maximum value in the engineering units displayed.
2. Set the **`Limiter Gain`** to 500 and adjust as needed. **`Limiter gain`** determines how aggressively the proportional control function will correct the error when the flow rate exceeds the maximum flow setting. A higher value will correct more aggressively, but is also more likely to oscillate near the flow limit.

Note: *If both flow limiting and pressure setpoint ramping are active when controlling pressure, the more restrictive function will regulate the controller's operation as it attempts to attain the setpoint.*

Using a Control Deadband for Pressure Control

`CONTROL → Control Loop → Control Deadband`

The control deadband is designed for pressure control applications to improve stability. There is no active control within the deadband setting.

To turn on the control deadband, enter a non-zero value in **`CONTROL → Control Deadband → Deadband`**. In order for the deadband to activate, the setpoint must first be reached by the controller. If the process variable drifts to a deadband limit, active control resumes until the setpoint is reached again.

The controller can be set to either hold the current valve position or close the valve(s) when in the deadband in **`CONTROL → Control Loop → Control Deadband → When in Band`**. It is recommended to hold the current position on LC-Series devices.

Example: When making a step change from 15 PSIG to a setpoint of 30 PSIG, a deadband of ±0.25 PSIG allows absolute pressure to vary between 29.75 and 30.25 PSIG. The device will increase pressure until it reaches the setpoint of 30 PSIG, then hold the current valve position until the pressure reading varies outside of the preset deadband.

Setpoint Ramping

Setpoint ramping regulates how quickly the controller will reach the flow or pressure setpoint. It is often used to prevent bursts of pressure or flow from damaging delicate instruments when starting a process.

To activate setpoint ramping, you will set a maximum ramp rate and configure when to enable the ramping function.

Setting the Ramp Rate

- **Ramp** is a quick way to change the maximum rate of change.
- **Units** is a quick way to change the engineering units used.
- **Set By Delta / Time** allows for more detailed control of the ramp rate including changing the value of the time period.

Ramping Options

Changing ramping options allows you to have a ramp in only one direction, increasing or decreasing. It also allows you to ignore the ramp rate when initially powering on or commanding a zero setpoint.

- **Ramp Up** can toggle between on and off. When off, the ramp rate will not be honored when increasing flow to reach a given setpoint.
- **Ramp Down** can toggle between on and off. When off, the ramp rate will not be honored when decreasing flow to reach a given setpoint.
- **Power Up** toggles between **Allow Ramp** and **No Ramp**. If set to **No Ramp**, the device will ignore the ramp rate just after powering on, otherwise it will honor the ramp rate.
- **0 Setpt** determines whether the controller ramps when a zero setpoint has been given. If this setting is set to **No Ramp**, when given a zero setpoint, the controller will immediately stop flow; otherwise it will ramp at the selected rate.

Note: *Setpoint ramping can be used with flow or pressure setpoints, depending on the control loop selected. Ramping for pressure control limits how quickly pressure changes before reaching the setpoint. To limit flow rates directly while controlling pressure, see* *page 14*.

Displaying Valve Drive Percentage

The valve drive is represented as a percentage of the amount of voltage driven to the valve. Percentages do not directly correlate with percentage open.

Viewing the valve drive percentage is particularly helpful for troubleshooting. A valve that has increased in percentage over time indicates a likely clog in the system where more voltage is required to drive the valve to attain the same amount of flow. A valve percentage of 0% indicates the valve is closed.

This information may be displayed on the **main display** as well as part of transmitted serial data. There are four valve display options:

- **None**: No valve information is displayed.
- **Main Screen**: Only on the **main display**.
- **Digital Data**: Only in the serial data frame.
- **Screen and Digital**: Both the **main display** and serial data frame.

Device Information

The **ABOUT menu** (**MENU** → **ABOUT**) contains useful information for setup, configuration, and troubleshooting.

Basic Device Information

ABOUT → About Device

This includes information on the following:

- **MODEL**: Device model
- **SERIAL NO**: Serial number
- **DATE MFG**: Manufacturing date
- **DATE CAL**: Most-recent calibration date
- **CAL BY**: Initials of the person who calibrated the device
- **SW**: Firmware version
- **Display SW** (color displays only): Firmware version of the display

Device Full Scale Ranges

ABOUT → Full Scale Ranges

This displays the maximum calibrated range of available flow and pressure readings. Most will include volumetric flow and gauge pressure.

Manufacturer Information

ABOUT → About Manufacturer

About Manufacturer usually includes:

- Manufacturer name
- Web address
- Phone number
- Email address

Setup

Sensor Setup

MENU → SETUP → Sensor

Choosing Engineering Units

SETUP → Sensor → Engineering Units

Changing device engineering units alters both the display and the data frame. Choose the parameter whose unit you want to change, and then select your desired engineering unit, confirming the change on the last screen.

Flow and Pressure Averaging

SETUP → Sensor → Flow Averaging
SETUP → Sensor → Pressure Averaging

Averaging the flow over a longer time may be useful in smoothing fluctuating readings. This menu changes the time constants of the geometric running averages for flow and pressure. Values roughly correspond to the time constant (in milliseconds) of the averaged values. Higher numbers generate a greater smoothing effect, to a maximum of 255 ms.

Zero Band

SETUP → Sensor → Zero Band

The zero band threshold is an amount of flow under which flow values are displayed as 0. The maximum zero band is 6.38%. This function also applies to gauge pressure readings when using the optional barometer. For example, a 10-LPM controller with a zero band value of 0.25% would display all readings between -0.025 and 0.025 LPM as 0 PSIG.

Configuring Serial Communications

MENU → SETUP → RS-232 Serial *or* RS-485 Serial

You can operate the flow controller remotely via its data connection for easy streaming and logging of all data. Before connecting the flow controller to a computer, ensure that it is ready to communicate with your PC by checking the options in this menu.

For more on how to issue commands from a computer, see page 19.

Unit ID

SETUP → RS-232 Serial *or* RS-485 Serial → Unit ID

The unit ID is the identifier that a computer uses to distinguish your device from other, similar devices when it is connected to a network. Using the unit ID letters **A–Z**, you can connect up to 26 devices to a computer at the same time via a single COM port. This is called **polling mode** (page 19). Unit ID changes take effect when you select **SET**.

If you select "**@**" as the Unit ID, the flow controller will enter **streaming mode** when you exit the menu (page 20).

Modbus RTU Configuration

SETUP → RS-232 Serial *or* RS-485 Serial → Modbus Address

Modbus Address

The Modbus address is the identifier that a computer or programmable logic controller (PLC) uses to distinguish your device from other devices when connected to a Modbus network. Values of 1–247 are available for use.

Modbus Idle Behavior

If a Modbus connection is idle for a specified amount of time, the device can be configured to set a zero setpoint. The idle time will be infinite by default, and can be set in seconds up to 99999.9 (1 day, 3 hours, 46 minutes, 39.9 seconds).

Baud Rate

SETUP → RS-232 Serial *or* **RS-485 Serial → Baud Rate**

Baud rate is the speed at which digital devices transfer information. The flow controller has a default baud rate of 19200 baud (bits per second). If your computer or software uses a different baud rate, you must change the flow controller's baud rate in the **BAUD menu** to ensure they match. Alternatively, you can change your computer's baud rate in Windows® Device Manager. Baud rate changes take effect once you press **SET**, but you may need to restart the software for it to recognize the change.

Display Setup

MENU → SETUP → Display

The options in the **display setup menu** adjust the contrast/brightness of the display and enable screen rotation.

Main Screen Options

SETUP → Display → MAIN Screen

- **Any Key Press** changes what happens when any of the parameter buttons on the **main display** (page 6) are pressed (pressure or temperature, for example). By default, these buttons highlight their measurement in the center of the display. If this option is set to **Show Actions Menu**, an option to change that parameter's engineering units will be shown, as well as an option to highlight the parameter.
- **Show Valve Drive** shows or hides the valve's drive percentage. See page 15.

Screen Lighting

SETUP → Display → Screen Lighting

The options and wording in the **screen lighting menu** will vary for monochrome versus color displays.

- On monochrome displays, press **LESS CONTRAST** or **MORE CONTRAST** to adjust the contrast levels and move the contrast indicator left or right. **POWER UP Lit** or **Dark** toggles whether the backlight of the unit will be on when the device powers on.
- On color displays, press **DIMMER** or **BRIGHTER** to adjust the brightness level and move the brightness indicator left or right.

Display Rotation

SETUP → Display → Display Rotation

The device has the option of inverting (flipping) the screen upside-down, as configured in this menu.

Advanced Setup

MENU → SETUP → Advanced

The **advanced setup menu** contains settings and detailed information that are useful when troubleshooting with customer support.

Factory Restore

SETUP → Advanced → Factory Restore

This will immediately take you to a confirmation screen. When troubleshooting, an applications engineer may recommend doing a **Factory Restore**. If something is not acting as expected, please contact an applications engineer prior to doing a **Factory Restore**.

Register Status

SETUP → Advanced → Register Status

The **Register Status** screen displays live values for the internal device registers. Many of these values can help an applications engineer diagnose operational issues over the phone. Some register values clearly distinguish between hardware and operational problems, which speeds up the troubleshooting process.

Edit Register and Device Properties

SETUP → Advanced → Edit Register
SETUP → Advanced → Device Properties

Warning: *Editing these settings may cause the device to become inoperable. Do not modify them without working with customer support.*

Serial Communication

Connecting your device to a computer allows you to log the data that it generates. The device communicates digitally through its communications connector and cable using a real or virtual COM port on your computer. This section of the manual shows you how to operate the flow controller using ASCII commands.

Establish Communication

After connecting your device using a communications cable, you will need to establish serial communications through a real or virtual COM port on your computer or programmable logic controller (PLC).

- If you have connected your device to a serial port, note its COM port number, which can be found in the Windows® Device Manager program.
- If you have used a USB cable to connect your device to your computer, then in most cases it will recognize your USB as a virtual COM port. If it does not, download the appropriate USB device driver at alicat.com/drivers and note the COM port number as found in Windows® Device Manager.

The controller will be configured with the following settings:

- **Baud:** 19200 (by default; others can be used if the computer, computer software, and the controller are all set to the same rate)
- **Data bits:** 8
- **Parity:** none
- **Stop bits:** 1
- **Flow control:** none

Alicat's Serial Terminal Application

Alicat's Serial Terminal is a preconfigured program for serial communications that functions much like the older Windows® HyperTerminal, with plain text in a command-line format.

Download Serial Terminal for free at alicat.com/drivers. Once downloaded, simply run SerialTerminal.exe. Enter the COM port number to which your device is connected and the baud rate of the flow controller. The default baud rate is 19200, but this is adjustable by entering the **RS-232 Serial menu** on your flow controller (page 17).

Modbus RTU Communication

For details on Modbus commands, please visit alicat.com/manuals for the Modbus operating bulletin.

Serial Streaming vs. Polling

Note: *In what follows, ↵ indicates an ASCII carriage return (decimal 13, hexadecimal D). For many devices, this is the same as pressing the Enter key. Serial commands are not case-sensitive.*

Polling Mode

Your device was shipped in polling mode with a unit ID of **A**, unless requested otherwise. Polling the device returns a single line of data each time you request it. To poll your device, simply enter its unit ID.

Poll the device: `[unit ID]↵`
Example: **a↵** (polls unit A)

You can change the unit ID of a polling device by typing:

Change the unit ID: `[current unit ID]@=[desired unit ID]↵`
Example: **a@=b↵** (changes unit A to unit B)

You can also do this via the device's front panel menu (page 6). Valid unit IDs are letters A–Z, and up to 26 devices may be connected at any one time, as long as each unit ID is unique.

Streaming Mode

In streaming mode, your device automatically sends a line of live data at regular intervals. Only one unit on a given COM port may be in streaming mode at a time. To put your device into streaming mode, type:

Begin streaming: `[unit ID]@=@↵`
Example: `a@=@↵` (puts device A into streaming mode)

This is equivalent to changing the unit ID to "@". To take the flow controller out of streaming mode, assign it a unit ID by typing:

Stop streaming: `@@=[desired unit ID]↵`
Example: `@@=a↵` (stops and assigns unit ID of A)

When sending a command to a device in streaming mode, the flow of data will not stop while the user is typing. This may make the commands you type unreadable. If the device does not receive a valid command, it will ignore it. If in doubt, simply hit ↵ and start again.

The default streaming interval is 50 ms, but this can be increased by changing Register 91 while the device is in polling mode:

Set streaming interval: `[unit ID] w91=[number of ms]↵`
Example: `aw91=500↵` (streams new data every 500 ms)

Taring

Before collecting flow data, be sure to tare your controller. If auto-tare is enabled, this can be accomplished by providing a setpoint of 0 for at least 2 seconds.

Manual taring can be accomplished through two separate commands for flow and pressure. Taring flow sets the zero flow reading and must be done when no flow is passing through the flow controller:

Tare flow: `[unit ID]v↵`
Example: `av↵` (sets flow reading to zero)

Taring pressure sets the zero pressure reading and must be done when the device open to ambient pressure:

Tare gauge pressure: `[unit ID]p↵`
Example: `ap↵`

Collecting Flow Data

Collect live flow data by typing the `[unit ID] ↵` command or by setting your flow controller to streaming. Each line of data for live flow measurements appears in the format below, but the unit ID is not present in streaming mode.

A	14.70	+24.57	+02.004	+02.004
ID	Gauge Pressure	Temperature	Volumetric Flow	Setpoint

Single spaces separate each parameter, and each value is displayed in the chosen device engineering units (page 17). You can query the engineering units of the serial data frame by typing:

Query live data info: `[unit ID]??d*↵`
Example: `a??d*↵` (returns the data frame descriptions)

Additional columns, including status codes (page 6), may be present after the last number. The unit ID appears in the data frame only when the flow controller is in polling mode.

Before attempting to send a setpoint to your controller serially, confirm that its setpoint source is set to **`Serial/Front Panel`** (page 12).

There are two ways to command a new setpoint over a serial connection, as described below. In either of these methods, the data frame returns the new setpoint value when it has been accepted as a valid setpoint.

This is how to send the desired setpoint value as a floating point number in the engineering units selected:

New setpoint: `[unit ID]s[floating point number setpoint]↵`
Example: `as5.44↵` (setpoint of +5.44 LPM)

In this method, your controller's **full scale range (FS)** is represented by a value of 64000, and a zero setpoint is represented

by 0. To calculate your intended setpoint, use the following formula:

Integer value = 64000 × [desired setpoint]/[device FS]

Example: A desired setpoint of +5.44 LPM on a 10-LPM liquid flow controller is calculated as 64000 × 5.44/10.00 = **34816**. The command to assign the setpoint based on this integer value is:

New setpoint: [unit ID][setpoint as integer where 64000 is FS]↵
Example: **a34816**↵ (setpoint of 5.44 LPM)

Quick Command Guide

Change the unit ID: [unit ID]@=[desired ID]↵
Tare flow: [unit ID]v↵
Tare gauge pressure: [unit ID]p↵
Poll the live data frame: [unit ID]↵
Begin streaming data: [unit ID]@=@↵
Stop streaming data: @@=[desired unit ID]↵
Set streaming interval: [unit ID]w91=[# of ms]↵
New setpoint: [unit ID]s[floating point #]↵
New setpoint: [unit ID][integer]↵
Hold valve(s) at current position: [unit ID]hp↵
Hold valve(s) closed: [unit ID]hc↵
Cancel valve hold: [unit ID]c↵
Query live data info: [unit ID]??d*↵
Manufacturer info: [unit ID]??m*↵
Firmware version: [unit ID]??m9↵ *or* ave↵
Lock the front display: [unit ID]l↵
Unlock the display: [unit ID]u↵

If you have need of more advanced serial communication commands, please download the serial primer at alicat.com/drivers.

Troubleshooting

If you run into trouble with installation or operation, get in touch with support (page 2).

General Use

Issue: *My device does not turn on, or has trouble staying on.*
Action: Check power and ground connections. Please reference the technical specifications to ensure you have the proper power for your model.

Issue: *The buttons do not work, and the screen shows* **LCK.**
Action: The flow controller buttons were locked out via a serial command (**[unit ID]l↵**). Press and hold all four outer buttons to unlock the interface.

Issue: *I can't read the display easily.*
Action: During the day, you can increase the visibility of the display by increasing the contrast or brightness (page 18). For monochrome displays under low-light conditions, push the bottom central button (located below the display) to turn on the backlight.

Issue: *The analog output signal indicates values lower than what appears on my instrument's display.*
Action: Analog signal voltage degrades over long distances. You can minimize this effect by using wires with a heavier gauge, especially in the ground wire.

Issue: *How often do I need to calibrate my device?*
Action: Annual recalibrations are recommended. Check your device's last calibration date by selecting **MENU** → **ABOUT** → **About Device**. If it is time to recalibrate, request a recalibration from customer support (page 2).

Issue: *I dropped my device. Is it OK? Do I need to recalibrate?*
Action: If it turns on and appears to respond normally, then it is probably OK. It may or may not need a recalibration. Give it a tare, and compare it against a known-good flow standard. If it checks out, keep using it, but tell us about the drop at your next annual recalibration so we can check it out for you.

Issue: *How can I see readings in different units?*
Action: From the main menu, select **SETUP** → **Sensor** → **Engineering Units**. From this menu, you can adjust any variable's units. For more information, see page 17.

Flow Readings

Issue: *The live flow readings won't settle down.*
Action: The device is very fast, so it can detect subtle variations in flow that may go unnoticed by your other devices. This sensitivity can help detect problems with pumps or flow controllers. You can lessen this sensitivity by increasing the flow averaging (page 20). Controllers use PD or PD^2I control loop algorithms to reach the setpoint given. These parameters are adjustable in the field. See page 13 for a quick guide on tuning.

Issue: *My controller won't reach its setpoint.*
Action: The flow rate is related linearly to the pressure drop across the device. If there isn't enough of a pressure difference between the inlet and outlet, the controller may not be able to reach setpoint. Often, increasing the inlet pressure will fix this issue.
If increasing the pressure doesn't help, check to see if there is a clog. Teflon tape can often get stuck in the flow channel and block flow. Make sure to clean out any loose Teflon tape and never tape the first two threads entering the device to help avoid this issue.

Issue: *My flow readings are negative.*
Action: Set a zero setpoint to see if the flow returns to 0 after 2 seconds. Under conditions of no flow, a negative flow reading can indicate a poor tare. Ensure that auto tare is enabled and give the controller a zero setpoint for at least 2 seconds.

Issue: *Does the controller work if it is laying down? Will it be accurate?*
Action: For small valve controllers, the answer is yes to both! The flow controller is internally compensated for any changes in orientation and can be used sideways, on its back, or upside-down. Corrosive-resistant devices should be tared again after changing orientation. Large-valve controllers should be operated with the valve cylinder vertical and upright.

Issue: *Can I put the flow controller on top of a vibrating device? Will it be accurate?*
Action: For small valve controllers, yes you can. The device is internally compensated for any changes in orientation; however, sensor noise will increase if the flow controller is vibrating. Large-valve controllers are not recommended for use on vibrating surfaces.

Issue: *My controller does not agree with another liquid flow controller I have in line.*
Action: Liquid flow controllers can normally be compared against one another provided there are no leaks between the two controllers. One common cause of inaccuracy, inconsistency, or unusual readings is air bubbles trapped in one or both of the legs of the differential pressure sensor. Bleed the ports (page 7) to remove this possibility. Another possibility is that the liquid has some contaminant or additive, such as antifreeze, that affects the viscosity of the liquid (page 6). A third possibility is an improper tare error (page 9).

Issue: *My flow readings won't change when flow changes.*
Action: If your flow readings won't change regardless of actual flow, your flow sensor may be damaged. Please contact support to troubleshoot (page 2).

Issue: *Can I use the controller with other liquids?*
Action: No. Your flow controller is designed specifically to work with only one liquid, typically water. For use with a different liquid, the device will require recalibration. Please contact us to submit a service request at alicat.com/service.

Serial Communications

Issue: *I can't communicate to the device when it is connected to my PC.*
Action: **1.** Make sure the baud rate your software and COM port required is the one your flow controller is using (**MENU** → **SETUP** → **RS-232 Serial** *or* **RS-485 Serial** → **Baud Rate**).
2. Check the flow controller unit ID (**MENU** → **SETUP** → **RS-232 Serial** *or* **RS-485 Serial** → **Unit ID**) to make sure you are addressing it properly with your serial commands.
3. Check the pinout (common pinouts are listed starting on page 25).
4. Make sure the COM number matches the one your software is using to connect to the flow controller.
5. On the external serial communications device (computer, PLC, *etc.*), be sure that the flow control (handshaking) settings are set as on page 19.

Still experiencing issues? Please contact support. See "Contact Information" on page 2.

Maintenance

Cleaning

This device requires minimal maintenance. If necessary, the outside of the device can be cleaned with a soft dry cloth. Avoid excess moisture or solvents. The primary cause of damage and/or long-term inaccuracy in these devices is contamination and/or corrosion damage. Liquid should be filtered for particulates or biological materials that may grow in the device (page 6). When removing these units from the line for any extended period of time, make an effort to remove all of the liquid from the device, as deposits of calcium or other soluble minerals can affect the accuracy of the device.

Caution: *If you suspect that debris or other foreign material has entered your device, do not take apart the flow body to clean it, as this will negate its NIST-traceable calibration. Please contact support for cleaning (page 2).*

Recalibration

The recommended period for recalibration is once every year. A label located on the back of the device lists the most recent calibration date. This date is also stored inside your flow controller and is visible by selecting **MENU** → **ABOUT** → **About Device**.

When it is time for your device's annual recalibration, contact support (page 2) with your device's serial number and your contact information.

Reference Information

Engineering Units

For more information on engineering units, see page 17.

Flow Units

Label	Notes
µL/m	MicroLiter per minute*
mL/s	MilliLiter per second
mL/m	MilliLiter per minute
mL/h	MilliLiter per hour
L/s	Liter per second
LPM	Liter per minute
L/h	Liter per hour
US GPM	US gallon per minute
US GPH	US gallon per hour
CCS	Cubic centimeter per second
CCM	Cubic centimeter per minute
cm^3/h	Cubic centimeter per hour†
m^3/m	Cubic meter per minute†
m^3/h	Cubic meter per hour†
m^3/d	Cubic meter per day†
in^3/m	Cubic inch per minute†
CFM	Cubic foot per minute
CFH	Cubic foot per hour
CFD	Cubic foot per day
count	Setpoint count, 0–64000
%	Percent of full scale

Total Units

Label	Notes
µL	MicroLiter‡
mL	MilliLiter
L	Liter
US GAL	US gallon
cm^3	Cubic centimeter†
m^3	Cubic meter†
in^3	Cubic inch†
ft^3	Cubic foot†
µP	Micropoise, a measure of viscosity*
mg	Milligrams
g	Grams
kg	Kilograms
oz	US ounces
lb	US pounds

Time Units

Label	Notes
h:m:s	Hours:minutes:seconds
ms	Milliseconds
s	Seconds
m	Minutes
hour	Hours
day	Days

Temperature Units

Label	Notes
°C	degrees Celsius
°F	degrees Fahrenheit
K	Kelvin
°R	degrees Rankine

True Mass Flow Units

Label	Notes
mg/s	Milligram per second
mg/m	Milligram per minute
g/s	Gram per second
g/m	Gram per minute
g/h	Gram per hour
kg/m	Kilogram per minute
kg/h	Kilogram per hour
oz/s	Ounce per second
oz/m	Ounce per minute
lb/m	Pound per minute
lb/h	Pound per hour

Pressure Units

Label	Notes
PaG	Pascal
hPaG	Hectopascal
kPaG	Kilopascal
MPaG	Megapascal
mbarG	Millibar
barG	Bar
g/cm^2G	Gram force per square centimeter†
kg/cm^2G	Kilogram force per square centimeter*
PSIG	Pound force per square inch
PSFG	Pound force per square foot
mTorrG	Millitorr
torrG	Torr
mmHgG	Millimeter of mercury at 0°C
inHgG	Inch of mercury at 0°C
mmH_2OG	Millimeter of water at 4°C (NIST conventional)†
mmH_2OG	Millimeter of water at 60°C†
cmH_2OG	Centimeter of water at 4°C (NIST conventional†
cmH_2OG	Centimeter of water at 60°C†
inH_2OG	Inch of water at 4°C (NIST conventional)†
inH_2OG	Inch of water at 60°C†
atm	Atmosphere
count	Count, 0–64000
%	Percent of full scale

** Displayed as kg/cmG.*

† Superscript and subscript numerals are displayed as lining (normal) numerals.

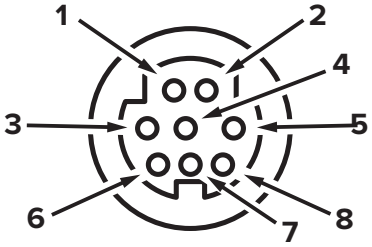
‡ Instances of µ are displayed as a lower-case u.

Pinouts

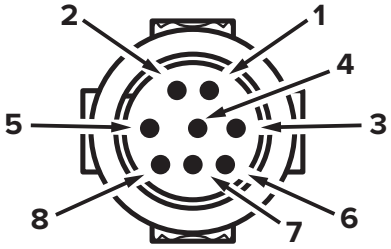
Check the calibration data sheet and pinout for your device.

See page 19 for additional important information about connecting your device to a computer for serial commands. Individual pinouts available at alicat.com/pinout.

8-Pin Mini-DIN (Default)



Female Connector: Device

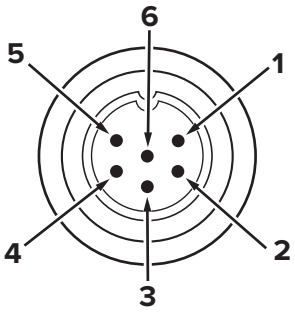


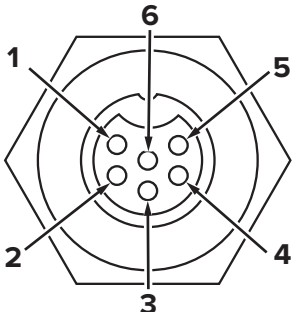
Male Connector: Cable

Pin	Function
1	Not connected *Optional: 4–20 mA primary output signal*
2	Static 5.12 Vdc *Optional: secondary analog output (4–20 mA, 0–5 Vdc, 1–5 Vdc, 0–10 Vdc) or basic alarm*
3	Serial RS-232RX input signal *Optional: RS-485 A*
4	Analog Setpoint Input
5	Serial RS-232TX output signal *Optional: RS-485 B*
6	0–5 Vdc *Optional: 1–5 Vdc or 0–10 Vdc output signal*
7	Power In
8	Ground (common for power, digital communications, analog signals, and alarms)

Caution: *Do not connect power to pins 1 through 6, as permanent damage can occur. It is common to mistake pin 2 (labeled 5.12 Vdc Output) as the standard 0–5 Vdc analog output signal. Pin 2 is normally a constant 5.12 Vdc.*

Locking Industrial Connector Pinout

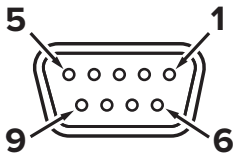




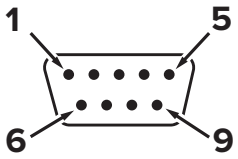
Pin	Function
1	Power In (+)
2	RS-232TX / RS-485 B
3	RS-232RX / RS-485 A
4	Analog Setpoint Input
5	Ground (common for power, communications, and signals)
6	Signal Out (voltage or current as ordered)

Note: *The availability of different output signals depend on the options ordered.*

9-Pin D-Sub Connector Pinouts



Female Connector



Male Connector

Pin	DB9 (Female) DB9M (Male)	DB9A / DB9K	DB9R	DB9T	DB9U
1	Current Out	NC	TX or B	TX or B	RX or A
2	Analog Out 2	Analog Out	Analog Out	Analog Out	Analog Out
3	RX or A	Power In	Analog In	Power In	Power In
4	Analog In	Ground	Ground	Ground	Ground
5	TX or B	TX or B	NC	NC	NC
6	Analog Out	Analog In	RX or A	Analog In	Analog In
7	Power In	Ground	Power In	Ground	Ground
8	Ground	Ground	Ground	Ground	Ground
9	Ground	RX or A	Ground	RX or A	TX or B

Pin	DB9B	DB9G	DB9H	DB9I	DB9N
1	Analog Out 2	RX or A	TX or B	NC	Power In
2	Analog Out	Analog Out	Analog Out	Analog Out	Analog In
3	Power In	Ground	Analog In	Power In	Analog Out
4	Ground	Power In	RX or A	Ground	NC
5	Ground	Ground	Analog Out 2	NC	Ground
6	Analog In	TX or B	NC	Analog In	Ground
7	Ground	Analog In	Power In	Ground	RX or A
8	TX or B	Current Out	Ground	RX or A	TX or B
9	RX or A	Ground	Ground	TX or B	NC5

Key of Terms:

Current Out
Not Connected

Analog In
Analog Setpoint Input

Analog Out
0–5 Vdc Output Signal (1–5, 0–10 Vdc optional)

Analog Out 2
5.12 Vdc or Optional Secondary Analog Output

TX or B
Serial RS-232TX or RS-485 B

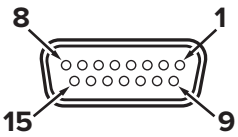
RX or A
Serial RS-232RX or RS-485 A

NC Not Connected

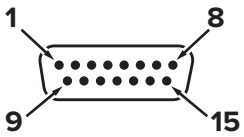
Power In (+Vdc)

Ground
Common for power, digital communications, analog signals, and alarms

15-Pin D-Sub Connector Pinouts



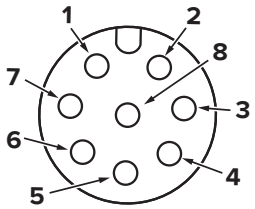
Female Connector: Cable



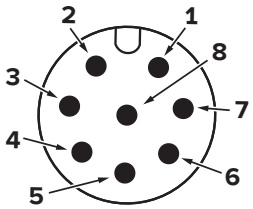
Male Connector: Device

Pin	DB15	DB15A	DB15B	DB15H	DB15K	DB15O	DB15S
1	Ground	Ground	Ground	NC	NC	Ground	Ground
2	Analog Out	Analog Out	Analog Out	RX or A	Analog Out	NC	Analog Out
3	Ground	Analog In	NC	NC	NC	NC	NC
4	NC	Ground	NC	NC	NC	Analog Out	NC
5	Power In	Ground	Power In	Ground	Ground	Power In	Ground
6	NC	Ground	NC	Analog Out	NC	NC	NC
7	NC	Power In	NC	Ground	Power In	Analog In	NC
8	Analog In	TX or B	Analog In	NC	Analog In	NC5	Analog In
9	Ground	Ground	Ground	NC	Analog Out 2	Ground	Ground
10	Ground	NC	Ground	Analog Out 2	NC	Ground	Ground
11	Analog Out 2	NC	Analog Out 2	Power In	Ground	Analog Out 2	Analog Out 2
12	NC	Analog Out 2	NC	Ground	Ground	NC	RX or A
13	RX or A	NC	NC	NC	RX or A	NC	Power In
14	Ground	NC	RX or A	Analog In	TX or B	RX or A	TX or B
15	TX or B	RX or A	TX or B	TX or B	Ground	TX or B	Ground

M12 Connector Pinouts



Female Connector: Cable



Male Connector: Device

Pin	M12	M12MD
1	**0–5 Vdc output signal** *Optional: 1–5 or 0–10 Vdc*	**Not connected** *Optional: 4–20 mA primary output signal*
2	**Power in**	**Static 5.12 Vdc** *Optional: Secondary analog output (4–20 mA, 0–5 Vdc, 1–5 Vdc, 0–10 Vdc) or basic alarm*
3	**Serial RS-232 RX signal** *Optional: RS-485 A*	**Serial RS-232 RX signal** *Optional: RS-485 A*
4	Analog Setpoint Input	Analog Setpoint Input
5	**Serial RS-232 TX signal** *Optional: RS-485 B*	**Serial RS-232 TX signal** *Optional: RS-485 B*
6	**Static 5.12 Vdc** *Optional: Secondary analog output (4–20 mA, 0–5 Vdc, 1–5 Vdc, 0–10 Vdc) or basic alarm*	**0–5 Vdc Output Signal** *Optional: 1–5 or 0–10 Vdc*
7	**Ground** (common for power, digital communications, analog signals, and alarms)	**Power in**
8	**Inactive** *Optional: 4–20 mA primary output signal*	**Ground** (common for power, digital communications, analog signals, and alarms)

Key of Terms:

Current Out
Not Connected

Analog In
Analog Setpoint Input

Analog Out
0–5 Vdc Output Signal (1–5, 0–10 Vdc optional)

Analog Out 2
5.12 Vdc or Optional Secondary Analog Output

TX or B
Serial RS-232TX or RS-485 B

RX or A
Serial RS-232RX or RS-485 A

NC Not Connected

Power In (+Vdc)

Ground
Common for power, digital communications, analog signals, and alarms

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